24590-PTF-N1D-CXP-P0007
Rev. 1

PLANT ITEM MATERIAL SELECTION DATA SHEET

R10667873

ISSUED BY
RPP-WTP PDC

CXP-VSL-00004 (PTF)
Cs IX Caustic Rinse Collection Vessel

- Design Temperature (°F)(max/min): 138/40
- Design Pressure (psig) (max/min): 15/FV:
- Location: incell
- PJM Discharge Velocity (fps): 40
- Drive Cycle: 17 % (at 40 fps)

OFFSPRING ITEMS

CXP-VSL-00006 – CXP-VSL-00009
CXP-PJM-00001, CXP-RFD-00004A/B
CXP-RFD-00005 – CXP-RFD-00006

Contents of this document are Dangerous Waste Permit affecting

Operating conditions are as stated on attached Process Corrosion Data Sheet

Operating Modes Considered:

- The vessel is filled with caustic rinse water.
- The vessel is filled with process condensate or demineralized water.
- No acid is present.

Materials Considered:

Material (UNS No.)	Relative Cost	Acceptable Material	Unacceptable Material
Carbon Steel	0.23		X
304L (S30403)	1.00	X	
316L (S31603)	1.18	X	
6% Mo (N08367/N08926)	7.64	X	
Alloy 22 (N06022)	11.4	X	
Ti-2 (R50400)	10.1		X

Recommended Material: 304 (max 0.030% C; dual certified)

Recommended Corrosion Allowance: 0.040 inch (includes 0.024 inch corrosion allowance and 0.004 inch erosion allowance)

Process & Operations Limitations:

- None

STEVEN WAKEMAN VAIL
STATE OF WASHINGTON
39250
REGISTERED PROFESSIONAL ENGINEER
EXPIRES: 12/07/07

3/14/06

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Corrosion Considerations:

This vessel allows recycle and reuse of the originally nominal 0.25 M NaOH solution from the Cs IX column. The solution exits the column with a nominal caustic concentration of about 0.1 M NaOH. This vessel can also receive fresh nominal 0.25 M NaOH solution as well as process condensate from one of the process condensate vessels.

a General Corrosion
The caustic rinse collection vessel collects rinse water from the IX columns during the wash cycle. The rinse solution is made up of diluted caustic solution with process condensate and/or demineralized water

Hamner (1981) lists a corrosion rate for 304 (and 304L) in NaOH of less than 20 mpy (500 μm/y) at 77°F and over 20 mpy at 122°F. He shows 316 (and 316L) has a rate of less than 2 mpy up to 122°F and 50% NaOH. Dillon (2000) and Sedriks (1996) both state that the 300 series alloys are acceptable in up to 50% NaOH at temperatures up to about 122°F or slightly above. Davis (1994) states the corrosion rate for 304L in pure NaOH will be less than about 0.1 mpy up to about 212°F though Sedriks states the data beyond about 122°F are incorrect.

In this system, the normal hydroxide concentrations and temperatures are such that 304L stainless steel will be acceptable.

Conclusion:
At the given temperatures, 304L and 316L are expected to be sufficiently resistant to the waste solution with a probable general corrosion rate of less than 1 mpy.

b Pitting Corrosion
Chloride is known to cause pitting in acid and neutral solutions. Dillon (2000) is of the opinion that in alkaline solutions, pH>12, chlorides are likely to promote pitting only in tight crevices. Dillon and Koch (1995) are both of the opinion that fluoride will have little effect in an alkaline media. If the chloride concentrations are low at the low pH and high at the high pH, then even the low pH conditions are expected to be benign towards 304L. Revie (2000) and Uhlig (1948) note nitrate inhibits chloride pitting.

Normally the vessel is to operate at 77 to 113 °F. At the normal temperature, based on the work of Zapp (1998) and others, 304L stainless steel would be acceptable in the proposed alkaline conditions.

If the vessel were filled with process water and left stagnant, there would be a tendency to pit. The time to initiate would depend on the amount of residual chlorides.

Conclusion:
Localized corrosion, such as pitting, is not expected. At the stated operating conditions304L will be suitable.

c End Grain Corrosion
End grain corrosion only occurs in metal with exposed end grains and in highly oxidizing acid conditions.

Conclusion:
Not likely in this system.

d Stress Corrosion Cracking
The exact amount of chloride required to cause stress corrosion cracking is unknown. In part this is because the amount varies with temperature, metal sensitization, and the environment. But it is also unknown because chloride tends to concentrate under heat transfer conditions, by evaporation, and electrochemically during a corrosion process. Hence, even as little as a few ppm can lead to cracking under some conditions. Generally, as seen in Sedriks (1996) and Davis (1987), chloride stress corrosion cracking does not usually occur below about 140°F. During the normal operations, either 304L or 316L are expected to be satisfactory.

Neither 304L nor 316L are susceptible to caustic cracking at the proposed conditions.

Conclusion:
At the normal operating environment, the alloy recommended is 304L.

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e Crevice Corrosion
See Pitting.

Conclusion:
See Pitting

f Corrosion at Welds
Corrosion at welds is not considered a problem in the proposed environment.

Conclusion:
Weld corrosion is not considered a problem for this system.

g Microbiologically Induced Corrosion (MIC)
The proposed operating conditions are not conducive to microbial growth if microbes were introduced.

Conclusion:
MIC is not considered a problem.

h Fatigue/Corrosion Fatigue
Not expected to be a concern.

Conclusions
Not a concern.

i Vapor Phase Corrosion
The vapor phase portion of the vessel is expected to be contacted with particles of waste from splashing. It is unknown whether this will be sufficiently washed or whether residual acids or solids will be present. Under the stated conditions, with wash ring present in the vessel, this is not expected to be a concern

Conclusion:
Not a concern.

j Erosion
Based on past experiments by Smith & Elmore (1992), the solids are soft and erosion is not expected to be a concern for the vessel wall. Based on 24590-WTP-RPT-M-04-0008, a general erosion allowance of 0.004 inch is adequate for components with solids content less than 2 wt%. No localized protection is necessary for the applicable portions of the bottom head to accommodate PJM discharge velocities of up to 12 m/s for a usage of 100 % operation as documented in 24590-WTP-M0C-50-00004.

The PJM nozzle requires no additional protection as documented in 24590-WTP-M0C-50-00004.

Conclusion:
The recommended corrosion allowance provides sufficient protection for erosion of the vessel.

k Galling of Moving Surfaces
Not applicable.

Conclusion:
Not applicable.

l Fretting/Wear
No contacting surfaces expected.

Conclusion:
Not applicable.

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m Galvanic Corrosion
No dissimilar metals are present.

Conclusion:
Not applicable.

n Cavitation
None expected.

Conclusion:
Not believed to be of concern.

o Creep
The temperatures are too low to be a concern.

Conclusion:
Not applicable.

p Inadvertent Nitric Acid Addition
Higher chloride contents and higher temperatures usually require higher alloy materials. Nitrate ions inhibit the pitting and crevice corrosion of stainless alloys. Furthermore, nitric acid passivates these alloys; therefore, lower pH values brought about by increases in the nitric acid content of process fluid will not cause higher corrosion rates for these alloys. The upset condition that was most likely to occur is lowering of the pH of the vessel content by inadvertent addition of 0.5 M nitric acid. Lowering of pH may make a chloride-containing solution more likely to cause pitting of stainless alloys. Increasing the nitric acid content of the process fluid adds more of the pitting-inhibiting nitrate ion to the process fluid. In addition, adding the nitric acid solution to the stream will dilute the chloride content of the process fluid.

Conclusion:
The recommended materials will be able to withstand a plausible inadvertent addition of 0.5 M nitric acid for a limited period.

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References:

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2. 24590-WTP-RPT-PR-04-0001, Rev. B, *WTP Process Corrosion Data*
3. CCN 000853, Zapp, PE, 1998, *Preliminary Assessment of Evaporator Materials of Construction*, BNF—003-98-0029, Rev 0, Westinghouse Savannah River Co., Inc for BNFL Inc.
4. CCN 130172, Dillon, CP (Nickel Development Institute), Personal Communication to J R Divine (ChemMet, Ltd., PC), 3 Feb 2000.
5. Davis, JR (Ed), 1987, *Corrosion, Vol 13*, In "Metals Handbook", ASM International, Metals Park, OH 44073
6. Davis, JR (Ed), 1994, *Stainless Steels*, In ASM Metals Handbook, ASM International, Metals Park, OH 44073
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9. Revie, WW, 2000. *Uhlig's Corrosion Handbook*, 2nd Edition, Wiley-Interscience, New York, NY 10158
10. Sedriks, AJ, 1996, *Corrosion of Stainless Steels*, John Wiley & Sons, Inc., New York, NY 10158
11. Smith, H. D. and M. R. Elmore, 1992, *Corrosion Studies of Carbon Steel under Impinging Jets of Simulated Slurries of Neutralized Current Acid Waste (NCAW) and Neutralized Cladding Removal Waste (NCRW)*, PNL-7816, Pacific Northwest Laboratory, Richland, Washington.
12. Uhlig, HH, 1948, *Corrosion Handbook*, John Wiley & Sons, New York, NY 10158

Bibliography:

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2. Jones, RH (Ed.), 1992, *Stress-Corrosion Cracking*, ASM International, Metals Park, OH 44073
3. Van Delinder, LS (Ed), 1984, *Corrosion Basics*, NACE International, Houston, TX 77084

PLANT ITEM MATERIAL SELECTION DATA SHEET

24590-WTP-RPT-PR-04-0001, Rev. B
WTP Process Corrosion Data

PROCESS CORROSION DATA SHEET

Component(s) (Name/ID #) Cs IX caustic rinse collection vessel (CXP-VSL-00004)

Facility PTF

In Black Cell? Yes

Chemicals	Unit[1]	Contract Max		Non-Routine		Notes
		Leach	No leach	Leach	No Leach	
Aluminum	g/l					
Chloride	g/l					
Fluoride	g/l					
Iron	g/l					
Nitrate	g/l	8.70E-04	1.01E-03			
Nitrite	g/l	1.30E-04	1.55E-04			
Phosphate	g/l	1.35E-04	1.58E-04			
Sulfate	g/l					
Mercury	g/l					
Carbonate	g/l	2.53E-04	2.78E-04			
Undissolved solids	wt%					
Other (NaMnO4, Pb,...)	g/l					
Other	g/l					
pH	N/A					Assumption 1
Temperature	°F					Note 2

List of Organic Species:

References
System Description: 24590-PTF-3YD-CXP-00001, Rev 0
Mass Balance Document: 24590-WTP-M4C-V11T-00005, Rev A
Normal Input Stream #: CXP13,CXP22,CXP14
Off Normal Input Stream # (e.g., overflow from other vessels): N/A
P&ID: N/A
PFD: 24590-PTF-M5-V17T P0012, Rev 0
Technical Reports: N/A

Notes:
1. Concentrations less than 1x 10^{-4} g/l do not need to be reported; list values to two significant digits max.
2. Tnormal operation 77 °F to 113 °F (24590 PTF-MVC-CXP-00004, Rev 0)

Assumptions:
1. Process condensate at pH 7, stream CXP13 has pH 13 (0.1M NaOH)

4.3.4 Cs-IX Caustic Rinse Collection Vessel (CXP-VSL-00004)

Routine Operations

The Cs-IX caustic rinse collection vessel (CXP-VSL-00004) allows recycle and reuse of the originally nominal 0.25 M NaOH solution. The Cs-IX caustic rinse collection vessel is designed to receive spent caustic regeneration solution that has been discharged from a Cs IX column (CXP-IXC-00001, -00002, -00003, or -00004) during the regeneration sequence.

The spent regeneration solution, which originates as a fresh 0.25 M NaOH solution before introduction into the column, exits the column with a nominal caustic concentration of about 0.1 M NaOH. This solution is then collected in the Cs-IX caustic rinse collection vessel for use in the LAW displacement sequence. During the column regeneration, 2500 gallons of fresh 0.25 M NaOH solution are fed to a column. A significant portion of the initial NaOH that is fed to the column reacts with the resin and, as a result, the initial solution exiting the column is depleted in NaOH. Only about half of the volume of the total batch of regeneration solution is captured for use in the LAW displacement sequence; since the later half has a higher strength in NaOH, it is captured. This is accomplished by valving the first portion of the exiting regeneration solution to one of the acidic/alkaline effluent vessels (PWD-VSL-00015 or -00016), and valving the second portion to the Cs-IX caustic rinse collection vessel.

For startup and makeup purposes, the Cs-IX caustic rinse collection vessel can receive fresh nominal 0.25 M NaOH solution from an outcell tank (SHR-TK-00005). It can also receive (as a source of water) process condensate from one of the process condensate tanks (RLD-TK-00006-A or -B) via a header. Some adjustment of the NaOH concentration can be made using these two sources. The solutions made in the Cs-IX caustic rinse collection vessel can also be used to cool Cs IX columns (through the use of flow-through cooling) in abnormal situations. Alternatively, the Cs-IX caustic rinse collection vessel can be used to receive batches of cooling solution that have passed through a column.

Non-Routine Operations that Could Affect Corrosion/Erosion

None identified.